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THE REPRESENTATION OF ADVERBS, ADJECTIVES AND EVENTS IN LOGICAL FORM

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ABSTRACT

The representation of adjectives and their adverbial counterparts in logical form raises a number of issues in the relation of (morpho)syntax to semantics, as well as more specific problems of lexical and grammatical analysis. This paper addresses those issues which have bearing on the relation of properties to events. It is argued that attributes and context play only an indirect role in the relation between properties and events. The body of the paper addresses the criteria for relating surface forms to logical form representations, and offers an unified analysis of adjectives and their adverbial counterparts in logical form while maintaining a clear distinction between operators and predicates; this requires the postulation of a factive sentential operator and the relaxation of the one-to-one syntax-semantics correspondence hypothesis. Criteria for determining the number of arguments for a predicate are established and are used for the analyses of phenomena such as passive-sensitivity, lexical derivational patterns, and gradability.

1 Introduction

The lexical classes "adjective" and "adverb" are distinguished in the surface structure of many natural languages, including English and the major European languages. While a fair amount of attention has been paid to the syntax and semantics of adjectives, only relatively recently have the syntax and semantics of adverbs entered the limelight. The analyses proposed for the representation of adverbs and adjectives in logical form have been quite different—partly because of the dissimilar history of such analyses in the field, but largely because they have tended to be syntax-driven; distinctions in the syntax of adjectives and adverbs have been reflected in distinctions in the logical forms proposed for them. Thus, adjectives have traditionally been analyzed as one-place predicates (or perhaps, for adjectives that take complements, as two-place predicates), since they can be predicated of noun phrases in predicative adjective constructions, and noun phrases yield arguments. Adverbs, on the other hand, have been analyzed as predicate operators, since they modify verbs or verb phrases, which are traditionally analyzed as predicates. In addition, all sentential adverbs have been analyzed as propositional operators because of a syntactic distinction between sentential and verbal adverbs.

In the past ten years or so, however, the semantics of natural language expressions, as developed by both linguists and philosophers, has freed itself more and more from a simple one-to-one correspondence with the surface syntax of English. Indeed, the easing of that constraint has enabled us to

explain some anomalous syntactic behavior. This paper will address recent semantic research in the area of adjectives and adverbs, with emphasis on its relation to the nature of events, and will argue for a more unified analysis than has previously been provided. In particular, we will argue that (1) the traditional analysis of a property as being a two-place attribute relation between an object and a value (e.g., **Color(Ford, red)**), is incorrect; (2) the proper semantic distinction is to be drawn between certain sentential adverbs, which are operators, and all remaining adverbs and adjectives, which are predicates of various types; (3) all the adverbs that have both sentential and verbal readings that are not clearly due to a lexical-semantic ambiguity can be unified in logical form as predicates; (4) the delinking of semantics from syntax extends, in the case of one subclass of adverbs, to morphology as well, and (5) many of the adjective/adverb pairs actually consist of an adjective derived from the adverb.

One of the more controversial issues in the representation of adverbs and actions will be assumed here: the need for an event variable. First proposed by Davidson [1967], this idea has been slowly but steadily growing in popularity, particularly in philosophy and artificial intelligence research. While this paper does not directly address the question of the validity of this analysis, its widespread usefulness and the unified analysis of adjectives and adverbs provided here should be taken as evidence for the analysis of events as individuals. In particular, the existence of two-place predicate adverbs, with one argument being the agent or subject of the sentence and the other the action itself, causes difficult problems for the most plausible alternative analysis of such adverbs, namely, as predicate operators.

2 Preliminaries

2.1 Lexical Semantics of Adverbs and Adjectives

Before analyzing the logical form of adjectives and adverbs, henceforth referred to as AA's, I shall list the major lexical semantic classes of adverbs that are relevant to this study, and the names for these classes that have been used in the literature. Besides serving to delimit the range of our study, this classification will provide a basis for the semantic issues to be discussed subsequently. This is not intended to be an exhaustive list of the lexical semantic classes that fall under the logical forms to be presented here; it is, however, a superset of the lexical classes of AA's whose semantic behavior has been discussed in the literature. Terms used by other authors are shown

in parentheses.

1. Operators
   (a) Modal ([Bellert 1971]; Epistemic [Ernst 1984a]): *possibly, probably, necessarily, not,* etc.
   (b) Evidential (Epistemic [Ernst 1984a]; Modal [Bellert 1971]): *evidently, obviously, allegedly, presumably,* etc.
2. Predicates
   (a) Two-place predicates [arguments for agent and event, proposition, etc.]
      i. Behavior (Agent-Oriented [Ernst 1984a]; $P_{subject}$ [Jackendoff 1972]): *rudely, nicely, politely,* etc.
      ii. Ability (Agent-Oriented [Ernst 1984a]; $P_{subject}$ [Jackendoff 1972]): *cleverly, foolishly, stupidly,* etc.
      iii. Intentional (Volitional [Ernst 1984a]; Passive-sensitive [McConnell-Ginet 1981]): *intentionally, willingly, reluctantly,* etc.
      iv. Evaluative (also [Ernst 1984a], [Bellert 1977]; $P_{speaker}$ [Jackendoff 1972]): *fortunately, surprisingly, luckily, oddly,* etc.
      v. Derived two-place Measure terms [see Section 3.4]
   (b) One-place predicates
      i. Emotional State (Mental State [Ernst 1984a]): *bitterly, angrily, gloomily, furiously,* etc.
      ii. Measure
         A. Normal: *successful(ly), beautiful(ly), good/well, tall, thin, short, slow, quick,* etc.
         B. Facility: *easy, tough, simple, difficult,* etc.
      iii. Qualitative: *red, black, dark, square,* etc.

[Note: Measure terms and other gradable AA's also have arguments for the reference set, as well as perhaps for the quantity or degree.]

There are a number of phenomena, labeled "adverbial" in the literature, that will not be discussed here. Of these, the most important are words, phrases, and clauses that refer to the time or location of an event. While these are clearly sentential adverbs in their behavior, current proposed extensions or modifications of first-order logic have specific ways of accounting

for time and location of events which are independent of the logical issues to be examined in this paper. The other major class of "adverbs" that will not be addressed comprises such verbal arguments as Instrument, Source and Goal, which have been called adverbs in the linguistic literature presumably because, unlike subject, object, and indirect object, they are syntactically optional, but which are clearly arguments of the appropriate verbal predicates.

There is a third class of adverbs that will also be disregarded in this paper: those that are derived from nouns and mean (to use the classic dictionary definition) "in some manner of, related, or pertaining to X", such as *electrically* in *electrically charged* or *electrically activated.* These are instances of the same kind of context-specific meaning relation as complex nominals, i.e., such constructions as *circuit board*, *syntax class*, etc. It has been demonstrated [Levi 1978] that adjectival forms derived from nouns that mean "of, related, or pertaining to X" behave syntactically and semantically like complex nominal constructions, and just happen to be syntactically adjectivalized because they are functioning "like" adjectives. Likewise, the denominal adverbs such as *morphologically* and *electrically*—like other adverbs with adjectival counterparts—take the adverbial morphology because they are functioning as modifiers of verbs or adjectives, a strictly syntactic fact.

2.2 The Status of Attributes

There is a long-standing philosophical tradition stretching back to at least Aristotle that treats properties (color, shape, size, etc.—the basic, "core" adjective concepts) as values of an attribute of the object rather than as directly predicated of objects themselves. Thus, *The box is red* would be analyzed as something like **Color(Box, Red)**—or, more abstractly, **Attribute(Box, Color, Red)** rather than simply **Red(Box)**. This analysis of properties and attributes has also been used extensively by those artificial intelligence traditions that employ "semantic nets" and "frames" [Woods 1975:50]. While this analysis is rather inelegant, it does appear to account for two constraints on adjective behavior. Adjectives (and adverbs as well [Bresnan 1982:164-65]) are usually considered to be recursive in the syntax; an arbitrarily great number of them can appear as modifiers of a single noun. There are two constraints on their (co)occurrence: they must be values of an attribute that the object denoted by the head noun possesses (e.g., **a red electron* is unacceptable), and no more than one can occur modifying

the same attribute (e.g., **a purple magenta book*, meaning a book that is both purple and magenta, rather than one whose color is a cross between purple and magenta, is unacceptable). The value-as-argument analysis of properties allows one to capture these constraints quite easily, while the value-as-predicate analysis does not seem to do so at all.

There is, however, an interpretation of attributes and values that allows us to maintain a logical form that does not explicitly represent the attribute, retain the value-as-predicate analysis, and nevertheless be able to account for the aforementioned constraints. Various English constructions support analysis of an attribute's values as belonging to a lower-level type, while the attribute itself is a higher-level type subsuming the attribute's values. Consider the following sentences:

(1) The book is red.
(2) Fido is a pug.
(3) Red is a color.
(4) The pug is a dog.
(5) My jacket is the same color as your book; it's maroon.
(6) That is the same dog as mine: it's a pug.

The adjective and attribute-name uses in the odd-numbered examples above are parallel to the even-numbered noun uses just below them. Examples 1–4 all use the "*be* of predication", which takes an individual (1–2) or a lower-level type (3–4) as the subject and an expression representing a type or a kind higher than that of the subject as the predicate (supported by the copula). Thus, in 1 *red* functions as a type, while in 3 *color* functions as a type higher than *red*.[1] The examples in 5–6 all use the "*be* of identity", asserting the equivalence of a type lower than *color* or *dog*, since it is obviously not being asserted that the two individuals themselves are identical. In 5, the lower level type is the value, *maroon*, which is exactly parallel to the lower-level type *pug* in 6.

If we adopt the analysis implied in the examples, i.e. that attributes constitute a higher-order type, then the two constraints discussed earlier emerge automatically from the standard behavior of type hierarchies. An individual cannot be a member of two disjoint sister sets at the same time; thus **a purple magenta book* is parallel to **a dog that is a cat.* Likewise,

[1]Predicate adjectives are also subject to a syntactic constraint against taking articles and plurals, thus resembling mass terms instead of count terms like *pug* or *dog*; a better example than 4 would be *Water is a liquid.*

an individual can be a member only of supersets of the basic set, so **a red electron* is parallel to **a dog that is a crime.*

Another aspect of attributes that suggests they should be left out of the logical form of AA's is their predictability. Unlike such phenomena as reference sets for measure terms, which have been shown to vary unpredictably and require an additional argument position in the predicate type (see footnote 14), the attribute is predictable from the value provided. The only exceptions to this rule are such value terms as *green*, which are ambiguous across attribute values—in this example, color vs. ripeness vs. emotional state vs. experience. In these cases, the ambiguity is always finite and lexically fixed, and so is of a completely different order of complexity from the reference set example.

Everything that has been said above concerning adjectives can also be stated mutatis mutandis with regard to verbal adverbs. These adverbs are analyzed as modifying an event variable, which can be thought of as a variable that describes an event or, more precisely, a process. Here again, [verbal] adverbs can be applied indefinitely to verbs, subject to the two constraints given above, and the attributes involved (result, direction, speed, etc. of the process) are actually higher-level types.

There is, however, one feature of the adjective-noun relation that is a priori unpredictable and requires context or world knowledge to disambiguate; this feature resembles that of complex nominal expressions such as *book department* or *glare screen*, in which the exact relation between the head and the modifier is left unspecified until the context can make it more precise [Downing 1979]. If one compares the phrases *a red apple* and *a mushy apple*, it is immediately evident what attribute is assumed in each case, i.e., color and texture, respectively—but the first attribute pertains to the surface of the apple, while the second pertains to its interior. In both cases, general world knowledge about the structure of apples and about which attributes of which parts of apples are most relevant to people determines that we are not dealing with a red-fleshed apple or one whose skin resembles foam rubber; on the contrary, this knowledge is both object- and context-specific. This leads to ambiguities that are potentially indefinitely large, just as with noun modifiers. Consider the following example (used by John McCarthy in a seminar at Stanford to make a similar point): *red* in *red pencil* could refer to the color of the pencil's surface, or to the color of the mark left after the pencil has been used to write or draw, or (in theory) to any other part or aspect of the pencil or its function which the speaker finds salient enough to describe. The chief difference between adjectival modifiers and

noun modifiers is that, in most cases, the part or aspect of the object that is appropriately described by the adjective is almost always determined by general knowledge about the object itself, the specific situational context contributing relatively little; on the other hand, the precise relation between the noun modifier and its head is established at least as much by the specific context of use as by our general knowledge. This aspect of adjectival behavior must be treated the same way as the corresponding behavior of noun modifiers. Thus, technically, any predication of a property should be of the form **Adj(F(x))**, in which **F** is a context-determined function from the entity **x** to the part or aspect of the entity that **Adj** is really a property of, just as a complex nominal form $[x\ y]_N$ is really **R(x,y)**, in which **R** is a context-determined relation that is the exact relation between the two entities. This added notational necessity is acknowledged here, but will be disregarded in the rest of this paper.[2]

3 Logical Types for Adverbs and Adjectives

3.1 Modal Adverbs: The Thomason and Stalnaker Tests

As stated above, the principal line to be drawn between classes of AA's at the level of logical form is between operators and predicates. The classic examples of operator adverbs are those that correspond to the modal operators: *possibly*, *necessarily*, and the sentence negator *not*. In addition, it is incontrovertible that the evidential adverbs such as *probably* and *evidently* are also sentence operators. The evidential adverbs all reflect different degrees of knowing something, in particular degrees of uncertainty of knowing something; therefore, under the possible worlds interpretation of knowledge

[2]It seems that the irregular semantic behavior of nouns and adjectives is associated with some characteristic of nouns themselves. All of those cases described in the literature in which compositional and referential semantics must take world knowledge and/or the specific context prominently into account have to do with nouns. In addition to the irregular compositionality in the syntax of adjective-noun and noun-noun constructions mentioned in the text, there is an irregular compositionality in the morphology associated with denominal derivations that is not found with deverbal or deadjectival derivations. Thus, for example, denominal verbs are highly irregular in their semantics; what Clark and Clark [1979] show for zero derivation is also true for nonzero derivation—compare *colonize*, *alphabetize*, *atomize*, or the innovation *productize*). The same is true of denominal agentive nouns: compare *scientist*, *machinist*, *violinist*, *communist*. Finally, as Geoffrey Nunberg has amply demonstrated [Nunberg 1979], simple nominal reference per se is also highly sensitive to world knowledge and context of situation.

and belief [Hintikka 1971], they are parallel to the modal operators.

Thomason and Stalnaker [1973] propose four criteria for deciding whether an adverb is sentential or not. Although they consider each test to be a sufficient condition in itself, a detailed study of individual adverbs indicated that, in most cases, all four conditions applied if any one did. More important to the current line of research is the fact that three of the four criteria test specifically for behavior that characterizes modal operators, at least in the possible worlds interpretation of modality. The first criterion is whether or not the adverb induces referential opacity in the entire sentence. While referential opacity is not unique to modal contexts and the like, it is characteristic of all of them. The same is true for scope ambiguity, the property used in the second criterion. Scope ambiguity is a feature of quantifiers as well as modal operators; however, in the possible worlds interpretation of modality, the basic modal operators behave like quantifiers over possible worlds. The third semantic criterion is whether or not the adverb is semantically appropriate in the context *It is Adv true that S.* In the sense that operators apply propositions to possible worlds and truth is defined as the applicability of a proposition in a world (i.e., truth is relativized to "truth in a world"), this criterion also is a criterion for operator status.[3] The remaining criterion, namely, that an adverb is sentential if it outscopes an adverb already proved to be a sentential modifier, is syntactic in nature and appears to be inessential, since, in all of the cases considered, the other criteria sufficed.[4]

[3]This test is closely related to a syntactic property of sentential adverbs, namely, that they can be paraphrased with their adjectival counterparts in the construction *It is Adj that S.* This fact places the adjective *likely* in the Evidential class—which its lexical semantics would certainly indicate—although, apparently for phonological reasons, it has no adverbial counterpart.

[4]There are some uses of Modal and Evidential AA's as adjectives modifying single nouns or fragments of noun phrases: *the alleged killer of the child, a possible solution,* etc. The meaning of these phrases can be paraphrased as *the person who is allegedly the killer of the child* and *a thing that is possibly a solution*; in logical form, this would simply be represented as an operator having scope over the relevant conjunction of predicates (represented here in a restricted quantification notation): **[the x: Alleged(Kill(x, child))]** and **[an x: Possible(Solution(x))]**. A similar analysis would be required for another subclass of adverbs: *hopefully, ideally,* and *desirably,* first noted by Ernst [1984a:71-73]; they would have to be modal operators over the entire sentence. Finally, adjectives like *fake, toy,* and *imitation* seem to require analysis as true predicate operators, since they alter the meaning of the predicate rather than the possible-worlds (i.e. epistemological/mental) status of the proposition. However, all the proposed operators—both sentential and predicate—have in common the fact that the truth of

3.2 S/V Adverbs and the FACT Operator

The discussion concerning Thomason and Stalnaker's criteria and its reference to the nature of operators (or rather, the shared properties of concepts that are represented as operators in logical form) highlights the problem of adverbs which appear to be ambiguous between sentential and verbal readings (S/V adverbs). If we adopt the interpretation of events as an independent argument of a predicate, as advocated by Davidson [1967], Moore [1981] and others, and argued for extensively by McConnell-Ginet [1981], then verbal adverbs will be predicates on that event variable. However, if there are adverbs that have both a verbal and a sentential reading (the latter proved by means of Thomason and Stalnaker's criteria), then we appear to be faced with one of two unpleasant alternatives: either to say that there are two otherwise synonymous terms, one an operator and the other a predicate, or that the single term is of one type, thereby forcing all verbal adverbs to be operators. Fortunately, there is a solution to this problem that reveals a "hidden" operator whose existence is supported by independent linguistic evidence.

Let us consider the example of Behavior adverbs such as *rudely* and *politely* and Ability adverbs such as *cleverly* and *stupidly*, etc. in which the distinction between the sentential and verbal readings is clearest. The following pairs of sentences, otherwise identical except for the position of the adverb, mean distinct things:

(7) Maggie spoke rudely to the Queen.

(8) Rudely, Maggie spoke to the Queen.

(9) Jerry opened the window cleverly.

(10) Cleverly, Jerry opened the window.

In the first sentence of each pair, the action was performed in a manner that is described by the adverb: it was perhaps Maggie's tone of voice or her use of brusque language that made the event rude, while it was presumably Jerry's technique in opening the window that was clever. This is clearly a verbal reading, with the predicate modifying the event variable. In the second sentence, it is the performance of the act itself (as opposed to its nonperformance) that is described by the adverb: Maggie was rude to speak to the Queen, while Jerry was clever to open the window at that time.

P(x) does not immediately follow from **OP[P(x)]** or **[OP(P)](x)**. While this is a general property of operators, it is not, as we shall see, a necessary one.

The readings in 8 and 10, generally called "sentential" readings due to their syntactic behavior, pose difficulties in analysis because they do not seem to fulfill Thomason and Stalnaker's semantic criteria for sentential adverbs. The sentential readings do not induce opacity in the sentence, the first criterion; in fact, unlike most other sentential adverbs, they are factive. When Thomason and Stalnaker's second criterion is applied, as in 11 and 12 below, one finds distinct readings under an interpretation in which one person speaking to the Queen is acceptable, but everyone speaking to the Queen at once is not:

(11) Everyone rudely spoke to the Queen.

(12) Rudely, everyone spoke to the Queen.

However, the phenomenon in 11 and 12 has a different explanation that is independent of the verbal vs. sentential adverb distinction. In another part of their paper, Thomason and Stalnaker [1973:200] point out that sentences like 13 and 14, with the adverb *slowly*—about as impeccable a verbal adverb as one can find—also display "scope ambiguity":

(13) Slowly, everyone left.

(14) Everyone left slowly.

In this case, as in 11 and 12, the "adverb wide scope" reading is actually a predication of the adverb over a distinct kind of event, i.e., the event of a collective group doing X, which happens to look like an aggregate of individual doing-X events. The property denoted by the adverb applies to that collective event (the slowness of everyone viewed as a group to leave, the rudeness of everyone viewed as a group to speak to the Queen). Thus, the phenomenon in 11 and 12 do not qualify as support for Thomason and Stalnaker's criterion.

Finally, the third criterion, acceptability in the frame *It is Adj that S*, does not appear to apply; 15 and 16 are not especially good English:

(15) *?It was rudely true that Maggie spoke to the Queen.

(16) *?It was cleverly true that Jerry opened the window.

Thomason and Stalnaker themselves argue that locative and temporal adverbs satisfy their third criterion, adducing 17 and 18 as evidence (Thomason and Stalnaker [1973:206]), but these examples are no more convincing than 15 or 16:

(17) *?It is true in the morning that Mary beats her dog.

(18) *?It was true in the kitchen that Henri dropped the souffle.

The sentential readings in 8 and 10 are characterized in a number of ways. First, unlike most sentential adverbs, they are factive. Second, it is just this factivity that the truth conditions for the sentential adverb reading are sensitive to: thus, it is the fact that the event in question falls under the description of "Maggie speaking to the Queen" that makes it rude. Nevertheless, the meaning of the adverb *rudely* (as well as *cleverly* and the like) is the same in both the verbal and sentential readings.

One must not confuse the meaning of utterances like 7-10 with explanations as to why the action, or its execution, is rude, clever, etc. Earlier proposals for analyzing 7 and 8 suggested that the difference between the verbal and sentential reading was that in 8 it was the fact that the action fitted the description provided by the proposition that made it rude, whereas in 7 it was some other description of the action (speaking loudly, using obscenities, etc.) that made it rude. However, what made the action of Maggie's speaking to the Queen rude in 8 may have to do with all sorts of things that may be quite remotely linked to the description. First, it may be that only part of the description is relevant to the reason for the action—e.g., the act of speaking to the Queen, not that of Maggie's speaking to the Queen. Or, conversely, it was only in the given context—not at all mentioned in the proposition under the "scope" of the adverb—that Maggie's speaking to the Queen was rude. The important point is that all sentence 8 asserts is that the fact that that event happened under those circumstances, as opposed to its not happening at all or to some other event's happening, was rude. Any inference as to the reason the fact that that event occurred was rude is not part of the semantics of 8. Likewise with 7: only some property of the event rather than its existence is asserted to be rude; the question what that property was or why it is considered to be rude is left open.

The verbal/factive-sentential ambiguity phenomenon appears to be present in all of the two-argument (actor and event) adverb lexical classes except for the Intentional class, and is usually the only reading available for the Evaluative subclass. The Emotional State adverbs such as *angrily*, whose semantics means roughly "**x** is such that one can infer that the agent was angry", has two distinct readings:

(19) Sue shut the door angrily.

(20) Angrily, Sue shut the door.

The preferred reading in 19 is that the manner in which Sue shut the door implied anger on her part, while the preferred reading for 20 is that the fact that Sue shut the door (say, the door to a dorm room during a hall party), as opposed to not doing so, indicated that she was angry. Even though both readings are possible in either position, the positional preferences for English adverbs merely tend to suggest the sentential or verbal readings for those adverbs that have both.[5]

Ernst [1984a] considers the possibility that Intention adverbs also display both readings:

(21) Sue closed the door deliberately.

(22) Sue deliberately closed the door.

There may be a reading of 22 that means that the manner in which Sue closed the door was deliberate on her part, while in 18 Sue's intention was to close the door; in addition, the sentence indicates her successful accomplishment of the act (the more common reading). If 22 is indeed a verbal adverb, it must be a derived one because it does not display the other behavior of Intentional adverbs, such as the opacity of the VP (see below).

Finally, with Evaluative adverbs like *fortunately* or *luckily*, as in 23, it is clearly the fact of Sue's shutting the door that is fortunate or lucky, not the manner in which she did it:

(23) Fortunately/Luckily, Sue shut the door.

However, some of the Evaluative adverbs do allow a verbal adverb reading, as noted by Ernst ([1984a:66], his examples 169 and 173):

(24) That performance turned out pretty luckily, considering all the trouble we had beforehand.

(25) Joan thought Fenster would be elated, but he reacted very curiously/strangely to the news.

Such examples are extremely rare, however.[6]

[5]The fact vs. manner distinction may not be present in the semantic representation of utterances with Emotional State adverbs; it may be only a part of the *reason* the agent was angry, etc., and so the arguments in the preceding paragraph apply. The lexical semantics of Emotional State adverbs appears to be vague rather than ambiguous with respect to the fact/manner distinction. See also the discussion of Emotional States AA's in Section 3.4.

[6]The factive readings of Evaluative adverbs, unlike those of other AA's, allow the para-

The solution to the dilemma of how to represent the semantic unity of the predicates that have both sentential and verbal adverb readings is to realize that there are two different things being characterized in the members of each pair.[7] The first is an event in the world, which is represented by the event variable. The second and more abstract one is the state of affairs of that proposition's being true. This, like an event, is part of the world; but, unlike events, it is something associated with every [true] proposition. This corresponds to the paraphrase of sentence 8 as *The fact that Maggie spoke to the Queen was rude*; the *fact* that Maggie spoke to the Queen is as much part of the world as the event that happened to be an instance of Maggie's speaking to the Queen. Indeed, the best way to test for the the sentential adverb reading of a predicate is to see whether the paraphrase *The fact that S is Adj* makes sense. To put it in terms suggestive of situation semantics [Barwise and Perry 1983], the state of affairs is the [factual] existence of something subsumed under a complex event type, e.g., "Maggie speaking to the Queen". No part of the description of the event is dispensable for the factive reading; still, for the reasons indicated above, one cannot draw any inference outside context as to what aspect or circumstance of the described event furnishes a rationale for the event's being rude or the like.

There is further evidence that supports this hypothesis. Adverbs like *rudely* or *cleverly* in their sentential readings (and also adverbs of the Evaluative class), can be applied to any sentence, including stative sentences. In the latter, however, the second, verbal adverb reading is absent—precisely because there is no event variable present. Thus, 26 has only one reading (the sentential one) and 27 is unacceptable because the sentential reading (the only possible one) is not possible with the adverb immediately following the main verb:

(26) Rudely, Fred was late to the Presidential dinner.

(27) *Fred was late rudely to the Presidential dinner.

Another prediction that one would make from the hypothesis is that

phrase *It is Adj that S*, e.g. *It is fortunate/lucky that Sue shut the door*; cf. **It was clever that Jerry opened the window*; the nearest acceptable paraphrase for the other classes requires the presence of the subject of the infinitive form in a PP: *It was clever of Jerry to open the window.* The reason for this appears to be that whereas in all the other AA classes the second argument to the predicate must be a participant in the action, this semantic restriction does not apply to Evaluative AA's (see section 3.4).

[7]This analysis was proposed by Robert Moore, in the course of discussions of this paper with the author.

the adverbs that are genuine operators, namely, the Modal and Evidential adverbs would not have any sort of verbal adverb readings with the same meanings. This prediction is also correct, as Ernst [1984b] has observed: in the case of those Evidential adverbs that do appear to have verbal adverb counterparts, the latter actually have meanings that differ from the corresponding sentential readings:[8]

(28) Clearly, John is right.

(29) John spoke clearly.

Furthermore, these classes of adverbs are not the only linguistic phenomenon to exhibit this semantic ambiguity. Such factive predicates as 30, first discussed by Kiparsky and Kiparsky [1970], also have two readings corresponding to those of *rudely* and *cleverly*, which are paraphrased in 31 and 32:

(30) Mary disapproves of John's drinking.

(31) Mary disapproves of the way John drinks.

(32) Mary disapproves of the fact that John drinks.

Finally, states of affairs, as well as events, enter into causal relations, so that the situation in 33a is described by 33b; note that no event variable could be involved, since the causal clause in 33a is stative. On the other hand, 34a exhibits both the manner and fact readings:

(33a) The President's being late caused the banquet to be delayed for two hours.

(33b) The fact that the President was late caused the banquet to be delayed for two hours.

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[8]The only possible exception to this rule seems to be *obviously*, which has a verbal adverb counterpart with a lexical semantics that does not appear to be distinct from the evidential form:

(*a*) Obviously, someone opened the door.

(*b*) Sandy opened the door obviously.

Sentence *b* means roughly "Sandy opened the door in a manner that made her action obvious", in the evidential sense of *obvious*. This was first pointed out by Ernst: "While a unified sense...works for *obviously*, it seems that no other Epistemic |Evidential| adverb admits of such treatment" [Ernst 1984b:87]. Unless a semantic difference between the two readings of *obviously* is found, this adverb may be a counterexample to our proposal.

(34a) John's drinking makes Mary upset.

(34b) The way John drinks makes Mary upset.

(34c) The fact that John drinks makes Mary upset.

Indeed, any natural language expression (nominalizations as well as complements) that can be paraphrased with *the fact that S* without altering the truth conditions of the utterance will be subject to the same kind of analysis as the phenomena described above.

All of this evidence confirms that a general systematic phenomenon is occurring here. The fact that the sentential readings exhibit the semantic behavior tested by Thomason and Stalnaker suggests that the "fact" reading should be characterized by an operator, which we will call **FACT**, which has scope over the proposition, and which denotes a function from the latter to a state of affairs. Hence, the two readings embodied in 7 and 8 would be represented as follows (**Rude** is a two-place predicate):

(35) $\exists e$[Speak(e, Maggie, Queen) & Rude(Maggie, e)]

(36) $\exists e$[Speak(e, Maggie, Queen) & Rude(Maggie, FACT(Speak(e, Maggie, Queen)))].

3.3 Adverbs of Intention

There is one class of two-place predicate AAs, referring to mental states, that behaves distinctly from all the other AA classes, namely, the Intentional class. The adverbs of this class do not have the S/V distinction, they induce opacity, and they display "passive-sensitivity" ([McConnell-Ginet 1981:145]; see below).

The distinctive behavior of the Intentional class of adverbs can be largely explained by treating them in a manner parallel to that applied to the verbs from which they are derived or to which they are related—i.e. verbs that denote intention, desire and knowledge, that have a proposition as one of the arguments of the predicate. Thus, just as with the Modal and Evidential adverbs, the S/V distinction is not relevant to the Intentional class. Like the lexically and semantically related verbs and adjectives of intention etc., the adverbs induce opacity:

(37) George intentionally/willingly attacked Ronald Reagan.

(38) George intended/was willing to attack Ronald Reagan.

(39) Ronald Reagan is the President of the United States.

(40) ⊬George intentionally/willingly attacked the President of the United States.

(41) ⊬George intended/was willing to attack the President of the United States.

In a situation in which George did not know that Ronald Reagan was the President of the United States, 40/41 do not follow from 37/38 and 39.

Unlike the Behavior and Ability adverbs, the corresponding verbal or adjectival forms of Intentional adverbs are not factive:

(42) Harvey was willing to cut the roast ⊬ Harvey cut the roast.

(43) Harvey was stupid to cut the roast before cooking it ⊢ Harvey cut the roast before cooking it.

The Intentional adverb forms themselves are factive (e.g., 37), indicating that (like all other adverbs, except the Modal and Evidential ones, and like most adjectives as well) two assertions are involved. Finally, like the corresponding verbal forms but unlike the Modal and Evidential adverbs, the Intentional adverbs take a second argument: the participant who intended, was willing, etc., to perform the action he has performed. Therefore, to capture all of these semantic facts, a logical form for 37 would have to be the one in 44; compare 45, which is the logical form of 38:

(44) $\exists e$[Attack(e, George, RR) & Intend(George, Attack(e, George, RR))]

(45) Intend(George, $\exists e$[Attack(e, George, RR)])

It is worth noting at this point that an anomaly in the interpretation of *intentionally* provides an additional piece of evidence for the existence of an event variable (as suggested by Robert Moore [personal communication]). Let us consider the following situation, taken from Searle ([1980:51]; in turn borrowed from Chisholm [1966]): John intends to kill his uncle, in order to collect early on his inheritance. He gets into his car to drive to his uncle's house, but in his haste to get there he runs over an old man—who, unbeknownst to John, is his uncle. Question: did John intentionally kill his uncle? If the standard notation without the event variable as in 46 is used, then the answer is yes, since there is no way to indicate that the killing of his uncle in the first conjunct is the same action as in the second conjunct, i.e., that John intended that very event to be the killing of his uncle. John clearly did not intend the event of the car accident to be the event of his killing his uncle—he had something completely different in

mind—and so the traditional representation makes an erroneous prediction. However, the representation that includes the event variable in 47 does make the correct prediction, because the identity of the event variable in the second conjunct with the one in the first conjunct means that John intended that very event to be the killing of his uncle; and since that assumption is false, the proposition is, correctly, false.

(46) Kill(John, Uncle) & Intend(John, Kill(John, Uncle))

(47) $\exists e$[Kill(e, John, Uncle) & Intend(John, Kill(e, John, Uncle))]

While the representation in 44 and 47 captures correctly the semantics of the Intentional class of adverbs, there is another property of this class that has generated considerable interest, having been discussed by Lakoff [1972], Thomason and Stalnaker [1973], and McConnell-Ginet [1981]: the phenomenon of passive-sensitivity.[9] When certain semantic conditions apply, it is possible to have two readings for 48 (with the positional variants favoring one reading over the other, but not always excluding the unfavored reading), one corresponding to the situation in which Joan is reluctant and one corresponding to the situation in which Fred is reluctant; these readings are paraphrased in 49 and 50:

(48a) Reluctantly, Fred was taught by Joan.

(48b) Fred reluctantly was taught by Joan.

(48c) Fred was reluctantly taught by Joan.

(48d) Fred was taught reluctantly by Joan.

(48e) Fred was taught by Joan reluctantly.

(49) Joan was reluctant to teach Fred.

(50) Fred was reluctant to be taught by Joan.

The possibility that either the subject or the agent (when the latter is not the subject) is the reluctant participant in the event constitutes the passive-sensitivity of the adverb. The semantic restriction governing the phenomenon of passive-sensitivity is the relevance of the potential of control[10] by the participant over the execution of the action; the adverbs

[9]This term was first used by McConnell-Ginet [1981:145].

[10]The potential for control, rather than control itself, is the correct way of stating the condition because adverbs like *unwittingly* or *unwillingly* indicate not that the participant has control over the action, but only that the potential for control was there, yet it was thwarted or not acted upon by virtue of ignorance, deceit, or some outright external force.

for which this is true are not just the Intentional adverbs but the Ability adverbs as well:

(51) Stupidly, the assistant was caught by the police while she was leaving the mayor's house.

(52) The assistant was stupid to be caught by the police while she was leaving the mayor's house.

(53) The police were stupid to catch the assistant while she was leaving the mayor's house.

While this ambiguity is a clear case for the necessity of another argument to the adverb besides the proposition, one still needs to explain how the two readings are possible under the conditions specified above. Superficially, the condition appears to be a disjunctive one: the other argument to the adverb must be either the agent or the subject. In the case of active sentences, agent and subject are the same, so only one reading is possible; in the case of passive sentences, agent and subject are distinct roles in the surface structure, so we have the ambiguity. McConnell-Ginet proposes that in the subject reading the adverb is associated with the higher verb, that is, with the passive auxiliary *be*, while in the agent reading the adverb is associated with the lower verb, the passive participle. While this solution is in itself somewhat questionable—the *by*-phrase that contains the agent argument in the passive construction is certainly outside of the VP immediately dominating the passive participle, no matter what one's analysis of auxiliaries may be—when one examines evidence from languages with morphological passives instead of syntactic ones, McConnell-Ginet's analysis is untenable. In such languages, her analysis would predict that there is only one reading, i.e., the agent-oriented reading, since there is no higher verb to attach the adverb to for the subject-oriented reading. However, in at least one language with a morphological passive, Japanese, both readings are possible.[11] Japanese has a passive suffix that occurs between the verb root and the tense/aspect marker (cf. 54 and 55):

(54) John-wa Mary-o osie-ta.
John-SBJ Mary-OBJ teach-PAST
'John taught Mary'

[11]The following data for Japanese were provided to me by Akira Ishikawa and Mariko Saiki.

(55) Mary-wa John-ni osie-rare-ta
Mary-SBJ John-AG teach-PASS-PAST
'Mary was taught by John'

When one inserts the adverb *husyoobusyooni* 'willingly' into 54, one gets only one reading for the sentence, since the agent and the subject coincide in surface structure; however, inserting it into 55 yields an ambiguous sentence, with the subject-oriented reading preferred when the adverb immediately follows the subject, and the agent-oriented reading preferred when the adverb immediately follows the agent phrase:

(56) John-wa husyoobusyooni Mary-o osie-ta.
John-SBJ unwillingly Mary-OBJ teach-PAST.
'John unwillingly taught Mary.'

(57) Mary-wa husyoobusyooni John-ni osie-rare-ta.
Mary-SBJ unwillingly John-AG teach-PASS-PAST
'Mary unwillingly was taught by John.'

(58) Mary-wa John-ni husyoobusyooni osie-rare-ta.
Mary-SBJ John-AG unwillingly teach-PASS-PAST
'Mary was unwillingly taught by John.'

Thus, the distinct readings in both the English and the Japanese cases are not dependent on the number of verbs in the clause, but instead on some deeper semantic relationship that goes against both the syntax and the morphology. The semantics of adverbs like *reluctantly* in 48-52 require that its first argument be an argument in the proposition that makes up the second argument of the adverb. Let us consider grammatical voice as an operation on logical form which makes available one argument (call it the "subject", reflecting its final surface-syntactic status) over the others, so that the (unmarked) active voice yields λx.Teach(e, x, y) and the passive alters the form to λy.Teach(e, x, y). Then, in the agent-oriented reading preferred in 48c-e and paraphrased in 49, the adverb was semantically composed with the predicate before the passive operation was applied, yielding 59, while in the subject-oriented reading preferred in 48a-b and paraphrased in 50, the passive operation was performed before the adverb was composed with the predicate, yielding 60.

(59) $\exists e$[Teach(e, Joan, Fred) & Reluctant(Joan, Teach(e, Joan, Fred))

(60) $\exists e$[Teach(e, Joan, Fred) & Reluctant(Fred, Teach(e, Joan, Fred))

This allows us to reanalyze the condition as a "subject" condition rather than as a disjoint subject-or-agent condition.

However, this means that one reading has to look "inside" the morphological structure of the passive form in order to combine it syntactically with another element of the sentence. This is not a unique and insuperable problem created by our analysis; it is just another example of a fairly widespread phenomenon, the best-known examples of which are given in 61 and 62:

(61) Morphological analysis: [un+[grammatical-ity]]
Semantic analysis: [[un grammatical] ity]

(62) Morphosyntactic analysis: [atomic [scient-ist]]
Semantic analysis: [[atomic scient] ist]

The more closely one analyzes linguistic constructions, the more ubiquitous the mismatches between syntactic structure and logical form turn out to be. For example, the entire analysis of adverbs argued for so far goes partially "against" the syntax of adverbs, with the division between [syntactically] sentential and verbal adverbs being different from the one between operators and predicates. While a rough-hewn correspondence between morphosyntactic structure and the structure of logical form is quite apparent, it is clear that the simple rule-to-rule hypothesis of compositionality it suggests must be refined considerably in order to account for the type of behavior described here.

3.4 Some Arguments for Some Arguments

Having described the different logical forms found in the adjective and adverb classes considered in this paper, it remains to examine the large number of AA's that are predicates and to determine the number and type of arguments the predicates of each class take.

There are three major criteria for establishing the need for an argument to a predicate. The first is that the concept denoted by the predicate necessarily implies the participation in some way of other entities—usually objects and agents, but also events, propositions, and even more exotic entities like the **FACT(P)** forms proposed earlier. The second is that the identity of those entities is not automatically predictable from the information already encoded in the predicate's semantics. The value-as-argument analysis of properties discussed in Section 2.2 did not satisfy this criterion, since in all cases the identity of the attribute is can be predicted from the

semantics of the predicate (the "value"); this was accounted for by determining that attributes are actually higher-level types and do not participate directly in the relation between the so-called "value" and the individual. The third criterion is whether or not the putative argument can actually appear in the utterance as a syntactic constituent dependent on the predicate word. Its presence means that some intimate relation holds between it and the predicate independent of contextual factors and the semantics of the predicate. Let us now examine the adverbial predicates and their adjectival counterparts in order to determine the relationship between them from the standpoint of how many arguments they take, what type they are, and which surface-syntactic form seems to he the basic one and which one, derived.

We have already seen that the agent (or rather, "subject") argument for Intention and Ability adverbs is a necessary argument of the predicate because it can vary in some circumstances, namely in passive constructions; thus, its identity is not predictable from the adverb's semantics. The adjective has the same meaning, even though it can be found attributed to an agent without the mention of an event:

(63) John is clever.

(64) John is clever at playing the dictionary game.

(65) John was clever to wait seven years before opening the 1974 Pommard.

The reason for this is that 63 is actually ambiguous, depending on the context: one could be uttering it in order to convey the idea expressed, for example, in 64 or 65 when the additional information supplied by the complements of the latter sentences is understood in the context. Out of context, of course, the usual interpretation of 60 would be that John is typically or generally clever in whatever he does—"generically" clever, so to speak (or, to be more specific, the second variable of **Clever(John, x)** is bound by a generalized quantifier **G**, as described by Farkas [1982]). Note that the generic-event reading covers both events and *the fact that S* types: John's general cleverness covers what he does as well as how he does it. This supports the generalized quantifier binding that the generic reading implies: the domain of the variable is not restricted in any way. Finally, it is obvious that sentences with explicit complements such as 64 and 65 will require a predicate with two arguments for the adjective, which strongly supports treating 63 as taking two arguments as well.

It turns out that, for almost all adverbs that are predicates on events and that have adjective counterparts like *clever* or *willing*, such adjectives are semantically identical to the adverbs. For example, with Behavior adverbs such as *rudely*, the adjective costructions semantically require an event as well as an agent, which is generic if unstated, as in 66, and which can be explicitly mentioned, as in 67 and 68.[12]

(66) Thomas is rude.

(67) Thomas was rude in speaking to the teacher.

(68) Thomas was rude to pull his sister's hair.

The Evaluative adverbs such as *fortunately* and *luckily* also are two-place predicates. In many cases the second argument is left to be implied by contextual factors, but it can appear as a distinct constituent in either the surface adjectival or adverbial form of the predicate:

(69) Fortunately for Tom, he left the house before the slide.

(70) John was lucky to get his application in before the deadline.

Unlike some of the other classes we have described, the second argument to Evaluative class forms may be related very indirectly to the action or state of affairs described in the first argument.

(71) Luckily for George, Harry threw the ball to Fred.

The Emotional State adverbs, on the other hand, seem to be one-place predicates that are syntactically derived from but semantically identical to their adjectival counterparts, which are one-place predicates on individuals, but do not have a different semantic form. The sentential-adverb form that *bitter* takes in 66 does not imply that the emotional state that Mary is in is related directly to the event which forms the main predication of the utterance. In fact, the form in 72 is a historical innovation based on the sentence type found in 73 and 74:

[12]The form in 68, with a *to* + infinitive construction (called here *to Vinf*), has only the factive-sentential reading, while the form in 64, with the *in* + gerund construction (called here the *at/in Ving* construction, since other variants take *at* instead of *in*), exhibits either the verbal or the factive readings, though the verbal reading is preferred. This distribution is a general fact about these nonfinite constructions: the *at/in Ving* constructions are used for verbal readings, the *to Vinf* constructions for the factive-sentential readings. The only exception to this rule is the use of a [gapped] *for-to* complement with Facility adverbs (see below).

(72) Bitterly, Mary left the apartment for the last time.

(73) Bitter, Mary left the apartment for the last time.

(74) Mary, bitter, left the apartment for the last time.

Further evidence supporting this argument is that when *bitter* is a predicate adjective, it cannot take a complement:

(75) Mary was bitter *to leave/*?in leaving the apartment for the last time.

The other one-place predicates are somewhat more complicated in their derivational structure: in some cases, there are actually other arguments, most of which are related to the phenomenon of gradability. The arguments contributed by the semantics of gradability will be discussed briefly at the end of this paper. We are primarily interested, however, in the relationship of the argument structure to the representation of events that has been proposed so far.

The Measure AA's actually have a very complicated semantics when it comes to the number of arguments and the existence of derived forms, although they are all verbal adverbs. Let us begin by considering those AA's that describe properties of processes or events. These include such AA's as *successfully* and *slowly*. Their primary use is as modifiers of events:

(76) Gerald slowly picked himself up off the floor.

(77) Marcel successfully merged his company with Limelight Industries.

The adjectival counterparts that are identical in logical form modify action nominalizations, since they are predicates on events:

(78) The destruction of the city by the Germans was rapid.

(79) The merger of the two chemical companies was successful.

However, there are adjectival forms of these AA's that take an individual as an argument, rather than an event:

(80) Muhammed is slow.

(81) Marcel is successful.

As has been pointed out by Uszkoreit [1980] and others, there is an understood role in 80 or 81 in which Muhammed is slow or Marcel is successful; this can be made explicit, as in 82 or 83:

(82) Muhammed is slow at learning languages (but fast at programming).

(83) Marcel is successful in merging companies (but not at composing operas).

It is also possible for 80 and 81 to be interpreted as meaning that, as a rule, Muhammed is slow or Marcel is successful in any activity either might undertake. Even 82 or 83 are generic as well, in that the role expressions are generic.

Nevertheless, in the original or "basic" uses of the AA in reference to an event, there is no need for an additional argument for, say, the subject: success in merging the companies may or may not be attributable to Marcel in 77 (cf. 79, which could be referring to the same event and does not refer to Marcel at all). Examples 80–83, however, indicate that actions of some type associated with the individual about whom the AA is predicated are generally slow, successful, etc. These adjectival uses are secondary applications that are derived from the primary one-place event predicate; they add a second argument and thus have the form **P(r,x)**, meaning roughly "**x** is **P** at doing **r**". The variable **r** denotes a *role*, that is, a generic activity such as running or learning languages, in which the individual mentioned in the other argument of the predicate is interpreted as the agent.

The distinctions are more complicated when one has an AA like *beautiful(ly)* which, in addition to modifying events, can also directly modify individuals—in this case, describing physical appearance. Thus, to borrow some well-known examples from Siegel [1976], we have the following two sentences and three logical forms, in which **Beautiful'** denotes the two-place predicate derived from **Beautiful**:[13,14]

(84) Marya dances beautifully.
$\exists e$[Dance(e,Marya) & Beautiful(e)]

[13]The interpretation of *beautiful dancer* in the first logical form listed under 85 is not a result of the mismatch phenomenon such as in example 62 above. Uszkoreit [1980] pointed out that the role variable in the derived adjectival form does not necessarily refer to the role denoted by the head noun in sentences like 85; his example is *John is a good sophomore* where in the context John is good at playing football. Thus, the role variable in the first logical form listed in 85 could theoretically refer to roles other than dancing.

[14]It is possible that the **Beautiful** predicate referring to physical appearance may be distinct (though obviously related) from the one-place predicate that characterizes events; see Footnote 15.

(85) Marya is a beautiful dancer.
Dancer(Marya) & $\exists r$[Beautiful'(r,Marya)] *or*
Dancer(Marya) & Beautiful(Marya)

The same sort of argument applies mutatis mutandis to Facility AA's, words expressing the facility of performing an action such as *easy/easily*, and *difficult/with difficulty*—the class of so-called "Tough-Movement" adjectives. They refer to actions as in 86; the adjectival use in 87 implies an action in which the individual of whom the adjective is predicated is a participant, e.g. the actions exemplified in the *to Vinf* complements in 88. The uses in 87 and 88 represent a two-place predicate derived from the one-place event predicate in 86, which does not specify any participant in the action as rendering the action "easy":

(86) Yolanda easily shot the arrow into the bullseye.

(87) This exam is difficult.

(88) This exam is difficult to read/to understand/to pass.

The chief difference between this class and the other Measure AA's is that the individuals of whom derived Facility adjectives are predicated must participate in the relevant actions as direct objects or as other affected participants, whereas the thematic relation between participant and action for the derived Measure adjectives is much freer (though it is usually the agent):

(89) *Daniel is easy to tease people. [=Daniel teases people easily]

(90) Daniel is successful at avoiding the draft.

(91) Daniel was successful in not being picked to head the commission.

Furthermore, the surface syntax for indicating the relevant role in a derived Facility AA form is a *(for-)to* complement rather than the *at/in Ving/Vnom* expression used for the derived Measure AA's.[15]

[15]The two derivational processes appear to be in complementary distribution. There is one antonymic pair of AA's that seems to function both as Measure and as Facility AA's: *good/well* and *bad/badly*; see examples *a*–*c*. However, the meaning of *a* is clearly not related to the meaning of *b* in the way it is related to the meaning of *c*:

(*a*) John played the Hammerklavier Sonata well.

(*b*) The Hammerklavier Sonata is good to play. [e.g. in order to get good reviews]

(*c*) John is good at playing Beethoven.

The predicate in *b* seems to be idiosyncratic and should be treated as distinct from the

Measure AA's actually take one or perhaps two other arguments that are related to their gradability rather than their applicability to both individuals and events. One of the defining characteristic of Measure AA's is that they are gradable—that is, the range of properties of a single attribute range over a [usually unidimensional] continuum, or at least, in the case of subjective measures like *good, cute* or *ugly,* are perceived to be ranked in such a way. Many of these AA's (*tall, little, shallow,* etc.) apply only to individuals and not events, and so do not share in the complications discussed above. In addition, many of the two-place AA's discussed above, such as the Behavior and Ability types (but not the Intentional AA's) are gradable, and so the following remarks pertain to them as well. Since a great deal has been written about gradability, and since gradability is somewhat peripheral to the basic issues surrounding the logical form of adverbs, I will present a brief, simplified discussion of the issues with respect to the predicate-argument structure of AA's.

The first additional argument taken by gradable AA's, whose existence is now relatively uncontested, is the "reference set" argument, denoting the class of individuals from which is derived the "average" value of the gradable property against which the AA in question is to be evaluated. To take a simple spatial-dimension term as an example, not only is *tall* vague as to what degree of height is intended, it is also indeterminate as to the assumable neutral point or region above which someone is considered to be tall and below which someone is to be considered short. Thus, in the following sentences, John and Jim may be the same height, yet one is "tall" and the other "short":

(92) John is tall for a fourteen-year-old.

(93) Jim is short for a professional basketball player.

Reference sets are relevant for "subjective" measure terms and other gradable terms, even though there is no universally agreed-upon metric that can be imposed on the domain:

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derivational pair in *a* and *c*. However, if this is true, then it is more difficult to argue that the use of *good* in *d*, in which it is intended to refer to some inherent moral quality of the individual, is the same predicate as the one in *a* rather than another distinct but lexicosemantically related form:

(*d*) Sam is good.

Such a proliferation of semantically related but distinct predicates may lead to difficulties later on.

(94) Jim is a good dancer, for a wrestler.

(95) Freddy is awfully rude, even for an eight-year-old.

Since reference sets are essential for the correct semantic interpretation of the AA, are not predictable from other information available in the utterance, and can be introduced into the utterance as independent arguments, one must include them as such. Thus, the use of *good* in an utterance like 96 actually has three arguments—individual, role, and reference set—that can be specified independently. Although, taken out of context, 97 is the usual interpretation of 96, the actual interpretation in a given context may be, e.g. 98:[16]

(96) The violinist is good.

(97) The violinist is good at playing the violin, for a violinist.

(98) The violinist is good at leading the musician's union, for a shy and reclusive person.

A more controversial question is whether sentences like 99–101 have a fourth argument that refers to the degree to which the individual possesses the value denoted by the AA with respect to the appropriate reference set (and role, in 101):

(99) Jim is six feet tall (*for a basketball player).

(100) Jim is pretty/very/extremely tall (for a basketball player).

(101) The violinist is pretty/very/extremely good.

While the specific value in 99 is most likely an argument—it is implied by the semantics of gradability, it is not predictable, and it can be represented explicitly (albeit optionally) in the utterance—that value term is syntactically parallel to the vaguer terms in 100 and 101, which are called "amplifiers" by Quirk et al. [1972:246, 444-51] and which denote a vague value on the scale represented by the AA. These latter forms have not been considered as arguments in the past, but the evidence from more precise measure phrases such

[16] If the adjective is attributive, it is extremely difficult though not impossible to obtain a reading in which the intended role is different from the activity associated with the head noun (usually an agentive nominal form). Moreover, the reference set is also usually interpreted as the same set as the one referred to by the part of the NP that follows the measure term in surface structure. For example, e.g. *a good Baroque violin player* would normally be judged against the reference set of Baroque violin players, not violinists in general or players in general.

as *six feet* suggest that they might be. However, precise measure phrases do not cooccur with phrases indicating the reference set, while amplifiers do; this suggests that, whatever analysis is chosen, more subtle constraints are required.

These brief comments on gradability are, of course, not conclusive. They are intended only to indicate that other factors will contribute to the argument structure of certain adjectives and adverbs, and that such factors must be distinguished from those that are consequences of the interactions of AA's with events (for example, role arguments are derivative arguments from the use of properties of events when predicated of individuals, while reference set arguments are part of the structure of gradability).

4 Conclusion

Our research on the semantics of adverbs and adjectives touches upon several interesting issues of general concern. In particular, it has led to arguments supporting the existence not only of an event variable for actions (but excluding states), but also for the state of affairs concept (represented by the **FACT** operator) as a distinct phenomenon. It has also led to further evidence for the separation of surface syntax from logical form. It is interesting to note, however, that adverbs themselves comprise a relatively unified phenomenon: a small class of operators on the one hand, a variety of predicates on the other. The lexical-semantic concepts denoted by specific adverbs (as represented in Section 2.1) are extremely diverse, belonging to domains such as mental states that have been explored very little until recently. Our analysis has, we hope, clarified a number of issues raised by the logical forms of most adverbs and adjectives, so that further research in these areas can be done on a firmer logical basis than has been possible hitherto.

Bibllography

Barwise, Jon and John Perry, 1983: *Situations and Attitudes* (MIT Press, Cambridge, Mass.).

Bellert, Irena, 1977: "On semantic and distributional properties of sentential adverbs", *Linguistic Inquiry*, vol. 8, no. 2, pp. 337-351.

Bresnan, Joan, 1982: "Polyadicity", *The Mental Representation of Grammatical Relations*, J. Bresnan, ed. (MIT Press, Cambridge, Mass.), pp. 149-172.

Chisholm, R. M., 1966: "Freedom and action", *Freedom and determinism*, K. Lehrer, ed. (Random House, New York).

Clark, E. V. and H. H. Clark, 1979: "When nouns surface as verbs", *Language*, vol. 55, no. 4, pp. 767-811.

Davidson, Donald, 1967: "The logical form of action sentences", *The Logic of Decision and Action*, N. Rescher, ed. (University of Pittsburgh Press, Pittsburgh, Penn.).

Downing, Pamela, 1979: "On the creation and use of English compound nominals", *Language*, vol. 53, no. 4, pp. 810-842.

Ernst, Thomas, 1984a: *Towards an Integrated Theory of Adverb Position in English* (Ph.D. dissertation, Indiana University, Bloomington, Indiana). Reprinted by the Indiana University Linguistics Club.

——, 1984b: Manner adverbs and the S/VP Distinction (unpublished manuscript, Indiana University).

Farkas, Donka, 1982: *Intensionality and Romance Subjunctive Relatives* (Ph.D. dissertation, University of Chicago, Chicago, Illinois). Reprinted by the Indiana University Linguistics Club.

Hintikka, Jaakko, 1971: "Semantics for propositional attitudes", *Philosophical Logic*, J. W. Davis, ed. (Reidel, Dordrecht).

Jackendoff, Ray, 1972: *Semantic Interpretation in Generative Grammar* (MIT Press, Cambridge, Mass.).

Kiparsky, Paul and Carol Kiparsky, 1970: "Fact", *Progress in Linguistics*, M. Bierwisch and K. Heidolph, ed. (Mouton, The Hague). Reprinted in *Semantics*, Danny Steinberg and Leon Jakobovits, ed. (Cambridge University Press, Cambridge, 1971).

Lakoff, George, 1972: "Linguistics and natural logic", *Semantics of Natural Language*, D. Davidson and G. Harman, ed. (Reidel, Dordrecht).

Levi, Judith, 1978: *The Syntax and Semantics of Complex Nominals* (Academic Press, New York).

McConnell-Ginet, Sally, 1981: "Adverbs and logical form", *Language*, vol. 58, no. 1, pp. 144-184.

Moore, Robert, 1981: "Problems in logical form", *Proceedings of the 19th Annual Meeting of the Association for Computational Linguistics*, Stanford, California.

Nunberg, Geoff, 1979: "The nonuniqueness of semantic solutions: polysemy", *Linguistics and Philosophy*, vol. 3, no. 2, pp. 143-184.

Quirk, Randolph, S. Greenbaum, G. Leech, and J. Svartvik, 1972: *A Grammar of Contemporary English* (Longmans, London).

Searle, John, 1980: "The intentionality of intention and action", *Cognitive Science*, vol. 4, pp. 47-70.

Siegel, Muffy, 1976: *Capturing the Adjective* (Ph.D. dissertation, University of Massachusetts, Amherst, Massachussetts).

Thomason, Richmond and Richard Stalnaker, 1973: "A semantic theory of adverbs", *Linguistic Inquiry*, vol. 4, no. 2, pp. 195-220.

Uszkoreit, Hans, 1980: "Do English adjectives come in two types?" (unpublished manuscript, SRI International).

Woods, William, 1975: "What's in a link: foundations for semantic networks", *Representation and Understanding: Studies in Cognitive Science*, D. Bobrow and A. Collins, ed. (Academic Press, New York).